the personal equation by the enumeration of the organisms, that makes biological work of this kind so valuable. Whatever errors creep into quantitative plankton studies—and no one knows better than the planktologist the inaccuracy of the methods—they occur in a similar way throughout, and affect all calculations to the same extent. The final result is a series of comparable observations, and the possibility of comparison is *the* keynote of quantitative plankton work.

Hensen's treatment of two of his critics does not seem quite fair. Kofoid's objection that the original net lost many of the smallest organisms has been upheld by the work of Lohmann. As for Herdman's work in the Irish Sea, the absence (which he has insisted on) of the uniform distribution of plankton necessary if observations made at stations far apart are to be of any value cannot be denied. Furthermore, it is just in waters like the North Sea and Irish Sea that most naturalists find it possible to work. Whatever may be the cause of the complexities in the Irish Sea, the variations which have been followed by the Port Erin workers have been of such magnitude that no small errors could invalidate the deductions drawn.

The influence of Hensen and his quantitative methods has been greater than at first sight would be imagined. There is no doubt that, as in many other cases, work along quite different lines has been stimulated or even created. Take, for example, the careful analyses of sea water, the study of the distribution of nitrogen, of silica, and hydrographic work in general. There was a continuous demand for very accurate knowledge from those who would explain distribution by the altered environment. It was the plankton expedition itself that startled biologists with the statement that life was more abundant in the Arctic and temperate waters than in the tropics, and out of this has arisen the ingenious attempts to explain the anomaly. Bound up with this is the search for the factors which govern the seasonal changes in the plankton and the detailed researches which have been made on the latter in seas and lakes throughout the world. The question of the food supply of aquatic organisms, now no longer a simple subject, but one bristling with unsolved problems, requires further research along many different lines, particularly chemical and physiological.

Finally, the systematist who follows the individual organisms, counting as they pass across the field of view, recognises the variations in shape and size, and hesitates before coining new species (especially if working through a year's catches). In fact, for the study of evolution we need to go to the simplest organisms existing under the most simple conditions of environment. For this purpose there is a wide field open for research in the plankton of warm waters. Hensen shows that the seasonal variations, which complicate so much plankton studies in our waters, are to a great extent absent in the tropics. It is probably the seasonal variations which are at the bottom of many strange features of distribution round our islands. It would be quite impossible to touch on the numerous points of interest (many of which should create discussion) in a short article. Victor Hensen must be congratulated upon the conclusion of a work to which he has given so much of an active life.

(2) Two other works which have recently been published may very conveniently be discussed here. The first deals entirely with those small organisms which pass through the finest tissue of which plankton nets are made.

Lohmann has proved himself to be one of the foremost plankton workers in the world, and it is to this man of science that we owe our knowledge of the limitations of Hensen's methods. Thus the methods of the Kiel school have received their critical tests at the hands of the Kiel school. Lohmann proposes to use the term "nannoplankton" for the very small organisms, both animal and vegetable, of the pelagic world.

At the present time Schütt's terms, macro-, meso-, and mikro-plankton, are usually employed. No exact definitions of these groups were ever given, but the macroplankton was understood to include such organisms as medusæ, whilst the rest of the plankton in a net catch belonged to the groups, meso- and mikroplankton. The former of these two divisions included the copepoda, worms, &c., and the protozoa and protophyta made up the second. To these three terms Lohmann adds two others: the "megaloplankton," for all large organisms visible from a ship's deck and varying in size from centimetres to metres, and the nannoplankton for the most minute forms.

Naturally, different apparatus is required for the collection of the nannoplankton, and the net has been supplanted by the centrifuge. Water can be bottled at any depth, and it has been found that quite small quantities suffice.

It must be remembered that though the actual volume of the nannoplankton is small, the degree of importance depends on the rapidity of multiplication and the duration of life of the organisms of this group, and in this respect their absence from the net catches of the plankton expedition is much to be deplored.

(3) The other work to be mentioned differs entirely from the above in being a text-book, and there can be no doubt whatever that such a book is necessary to-day in consequence of the great extension of plankton work during the last few years. This volume gives a detailed and fair description of all the methods employed, with the results of recent researches in seas, lakes, and rivers.

Its greatest value will be perhaps to those biologists and general scientific workers who wish to obtain information about this branch of biological science without wading through the vast number of small papers which have been already published. Prof. Steuer is to be congratulated on the very able way he has brought so many different lines of work together, and the volume ought to find a place waiting for it in most university libraries. W. J. DAKIN.

UNIVERSITY REFORM IN NEW ZEALAND.

IT may be taken for granted that all universities are not built on the same pattern; that local conditions and the requirements of the population have to be taken into consideration. The American and German universities, with their plans of government and conditions of study, meet the requirements of the respective peoples; Oxford and Cambridge, with features in common with one another, differ widely from the rest of the British universities in many respects. The type of the Scotch universities is unlike that of the modern English institutions, such as Liverpool and Manchester, while that of London is organised in a fashion peculiar to itself.

It is not to be wondered at, therefore, that the University of New Zealand should present anomalies in its constitution; the peculiarly isolated position of the country, the great difficulties of communication between its chief towns, especially in early days; the paucity of university men both on the staffs of the colleges and outside their walls at the period of its foundation; the local prejudices, amounting almost to

jealousies, which existed between the provinces into which the colony was once divided—these and other local conditions have led to a unique relation between the four university colleges and the University itself. The latter is governed by a Senate largely consisting of laymen without any connection with teaching, though a proportion of its members are professors at the colleges. Each of the colleges is governed by a council, on which, in three of the colleges, professors have no seat; while the professorial board in each deals with the real academic work of its college.

The constitution of the Senate and college councils is open to criticism, and it is felt in some quarters that the professors have not sufficient representation on these bodies.

But perhaps the most curious feature of the University is to be found in the method of granting degrees in arts, science, and laws. The University is purely an examining body; by it the examiners are appointed, and these examiners, eminent men in their subjects, are resident in Britain. They set the papers, to them the candidates' answers are transmitted, and their reports are sent out to New Zealand. Everyone agrees that this method is cumbrous, entailing much delay and inconvenience to candidates; while the professors at the colleges have no direct share in examining for the degrees. In early days, no doubt, various causes led to some such arrangement; but it is felt by some of the younger members of the professorial staff, fresh from English universities, with totally different traditions and local conditions, that the time is ripe for some change.

Hence has arisen a Reform Association, the executive of which has issued a booklet of some 200 pages,[1] dealing fully, and on the whole impartially, with the various grievances complained of, viz.: the organisation of the University; appointments to chairs in the colleges; finance; examinations; libraries; research; with suggestions for reorganisation; followed by an appendix containing the opinions of a large number of professors, British and American, on the questions of external examinations and the constitution of the governing bodies.

Many of the grievances are domestic in character, such as libraries, laboratories, appointment of professors, and can only be dealt with by the individual colleges; and it is all a matter of money; but there are one or two points of wider importance which may be discussed here.

It is within our knowledge that the originators of this reform movement are members of Victoria College, Wellington, and that the entire staff even of that college is not wholly in sympathy; nor can it be said that the staffs of the other three colleges are in complete accord with the views of the reformers. This is partly due to the failure of the originators to consult the professorial boards officially or to discuss with the older members of these boards the plans for reform advocated: so that the pamphlet must not be taken as expressing the views of the whole body of university teachers in New Zealand. There is no doubt room for reforms, though it appears to us that some of the grievances about the constitution of the Senate, for instance, are exaggerated. We may remind the reformers that even in the ancient universities of Oxford and Cambridge the final body court of appeal, Convocation, consists "of a fortuitous concourse of members who happen to be able and willing both to pay for keeping their names on the books and to be present in Oxford on a particular day"—to vote for or against reform. The majority of these men are "laymen" so far as university teaching is concerned; and it is interesting to note that the teachers and active members of the University of Oxford are hampered as much as—nay, more than—the teachers in New Zealand, in their efforts for reform.

As a matter of fact, in New Zealand, if the four teachers of a given subject are unanimous in desiring any alteration in the syllabus of their subject, the Senate invariably adopts their proposals. Even the appointment of the examiners is virtually in the hands of the teachers, for if the four professors of a given subject send up a recommendation to the Senate, it is acted on; but, of course, if no suggestion is made, the Senate has to make the appointment. Again, the professorial boards of the four colleges are consulted on nearly every point of importance before the matter is dealt with in Senate. It is true that more frequent conferences between these boards are desirable, and if annual conferences were arranged, many reforms would probably be introduced.

But the chief need seems to be an alteration in the present system of examination for degrees. We need not here discuss the advantages that have been claimed for this procedure—the uniformity and impartiality of the examinations; the maintenance of a standard and stimulation of the teachers; and the enhancement of the value of the degree—these are dealt with fully in the report, and it is claimed that the disadvantages outweigh these supposed advantages. The system is unanimously condemned by the British professors who have replied to the questions submitted to them.[2] The majority of the gentlemen whose replies are recorded have no acquaintance with the geographical conditions of the Dominion, nor is it clear whether the examinations for honours and scholarships were in their minds; we think that, in the case of these competitive examinations between men from different colleges, an external examiner is necessary, if only in justice to teacher and student. The discussion refers to pass examinations only.

But while it is easy enough to see the faults of the system, it is not quite so easy to substitute a new plan, as may be seen in the varied proposals submitted.

Three alternatives have been suggested:—

(1) That each of the four colleges should be an independent university. In theory, no doubt, this seems plausible; but when we remember that the highest number of students at any college is about 400 (and in others much less) and the total population of the Dominion only about one million, it does not seem desirable at present to have four different standards for the degrees in arts and science. For it must be borne in mind that while most of the professors have had a training in a British university, there are some who do excellent work indeed, but who have no experience of any higher standard of work than that at their own small college in New Zealand; and, especially in the case of science, this is detrimental. It is agreed that the present standard for the degree is a low one, at any rate in several subjects, and one understands that this must be the case when matriculation can be passed by children of fourteen years of age, and the entrance scholarship, for which the schools prepare, is almost of the same standard as the B.A.

[1] "University Reform in New Zealand." Published by the General Editors (Profs Hunter, Laby, and von Zedlitz) under the direction of the University Reform Association. Pp. 196. (Wellington, N.Z., and London: Whitcombe and Tombs, Ltd., 1911.)

[2] Though the opinions of acting professors in New Zealand are not included, those of six past professors or graduates of New Zealand are recorded; it is noteworthy, however, that Prof. Rutherford, whose views would be valuable, offers no comments on the system. Each of these six men gives an opinion more or less different from the other five, and amongst them may be found all the various possible plans for degree examinations and for reorganisation.

(2) A second proposal is that the teachers of a subject at the four colleges should form a board of examiners—either four (or only two) to constitute the board. Presumably each member would set a portion of the papers; in this case, if the four men act, the students at each college would recognise the "pet" questions of their teacher, which, although forming only a portion of the paper, would receive fuller answers than the rest of the paper, and this would mean, practically, that each college would be holding its own examination. Consequently the result would be essentially the same as in the first case. Moreover, the suggestion that all four teachers should cooperate is not quite so feasible as would appear; they would, of course, have to meet on several occasions, and though it is easy enough for a man in Edinburgh or Glasgow to run up to London in a few hours to confer with his co-examiner, yet the geography of New Zealand renders travelling less easy. Auckland and Dunedin are separated by nearly 900 miles, and this journey occupies at least sixty hours. It would be very inconvenient, to say the least, for these two men to spare time to meet, even at a midway point, while the cost to the University of such a scheme would be very heavy. Moreover, details of procedure would be far from easy to arrange.

(3) The purely external system of examination is condemned by most authorities. The real feature of the grievance lies not so much in having the examination for degrees conducted by external examiners in Britain or elsewhere, as in the total exclusion of the teachers from this examination; and it seems to us that the best suggestion is one made by two or three of those consulted, viz. that the teacher of a subject should make a report on each student, which would be forwarded to the examiner, who would take it into consideration in his award. For it is manifestly unjust to a candidate who has worked well throughout the year to be judged only by his answers to a paper, written on a day on which he may be unwell or otherwise unfit.

Every student, before presenting himself for the degree examination, has at present to pass an examination held by his teacher, and in the case of science a practical examination in addition must be done to his satisfaction. The marks awarded in these, if sent to the external examiner, would influence him in his award.

Indeed, it happened on one occasion that the degree had to be awarded entirely on these college examinations, for the ship conveying to England the candidates' answers was wrecked, and all the papers lost.

The reformers cavil at the small encouragement the university colleges give to research, while, as the pamphlet points out, there is opportunity but for a limited amount of original investigation. They rightly complain of the bugbear of examination if it be regarded as the "be-all and end-all" of university training; but, since the examination is part of the British system precedent to obtaining a degree, it is hopeless for a small colony like New Zealand to attempt to eradicate this evil so long as the Mother Country adheres to it.

In New Zealand there is no leisured class who can afford to spend time in pursuing knowledge for its own sake, and the degree is chiefly required by those entering the teaching profession, who must have a fairly all-round training in subjects useful for their purpose.

To such men and women specialisation at an early stage in the university career would be fatal to their prospects; there is no demand for specialists in chemistry or physics or biology, and it would be a cruel thing to encourage a man to spend two or three years in research, with no available opening at the end. Moreover, the libraries and staffing of the colleges are insufficient, as the reformers emphasise, for extensive research, which is best left to the later stages of a man's career, viz. for honours. What sort of research can a student in New Zealand pursue in languages?

It seems clear, however, that certain reforms are needed, but we fear that the reformers must not expect that all their grievances will be rectified immediately.

EXPERIMENTAL ERROR IN AGRICULTURAL INVESTIGATIONS.[1]

IN view of the large number of agricultural experiments carried out in the country it is very desirable that some attempt should be made to put them on a sound basis, so that the results shall have some permanent value and admit of definite interpretation. The experiments cost a good deal of money, practically all of which is found by public bodies, and the work is frequently carried out without any particular regard to scientific method.

Perhaps the most serious defect hitherto has been the ignoring of experimental errors, so that only in very few cases could the experimenter say what degree of accuracy he had obtained or what was the significance of the differences he observed. In order to provide a remedy a day was devoted to the subject at the agricultural subsection to the British Association in 1910, and some of the papers then read have been amplified, and are now issued as a supplement to *The Journal of the Board of Agriculture*.

They are all couched in simple language, and bring home the fact that the value of an experiment depends on the degree of confidence that can be attached to the result. The opening paper, by Messrs. Hall and Russell, deals with field trials, and the general conclusion is reached that the probable error attaching to a single experiment is at least ±10 per cent. It is possible to reduce the error to about ±2 per cent. by repeating the experiment simultaneously on a number of plots, which need not be more than 1/50th acre in extent.

The second paper, by Prof. Wood, discusses analytical results, the sampling of crops, field trials, and feeding experiments, and contains frequency curves and tables of odds, setting out the least significant differences in these usual conditions of the various classes of determinations. The agricultural experimentalist will do well to submit his figures to the simple tests suggested here.

Mr. Pickering deals with experimental errors in horticultural work, which are fairly considerable, and commonly ignored. The experiments and their interpretation are more difficult than in purely agricultural work, and according to the quantity estimated may vary from ±16 to ±20 per cent. for a single tree, or from ±6 to ±8 per cent. for a set of six trees.

Milk investigations are discussed by Mr. Collins. An ordinary fat analysis is shown to be liable to an error of ±0·03 per cent., while the error in the solids-not-fat determination can be reduced to 0·05 per cent., but may be higher.

The Board of Agriculture has undoubtedly rendered very useful service by issuing these papers in so cheap a form, and it is to be hoped that they will be used as extensively as the importance of the subject warrants.

[1] Supplement No. 7 to the Journal of the Board of Agriculture, 1911.